Is Right Sleeve Lower Lobectomy Necessary? Is It Safe?

Celalettin Ibrahim Kocaturk[1] Ozkan Saydam[1] Celal Bugra Sezen[1] Cem Emrah Kalafat[1] Levent Cansever[1] Ali Cevat Kutluk[1] Hasan Akin[1] Muzaffer Metin[1]

[1] Department of Thoracic Surgery, Yedikule Chest Diseases and Thoracic Surgery Education and Research Hospital, Istanbul, Turkey

Thorac Cardiovasc Surg 2020;68:235–240.

Address for correspondence Celal Bugra Sezen, MD, Department of Thoracic Surgery, Yedikule Chest Diseases and Thoracic Surgery Education and Research Hospital, Kazlicesme Mh, Belgrat Kapi yolu Cad No:1, Zeytinburnu, 34020 Istanbul, Turkey (e-mail: info@bugrasezen.com).

Abstract

Objectives The right sleeve lower lobectomy is the least used of the bronchial sleeve operations. There are only case-based studies in the literature. In this study, we compared this technique to those used in patients who underwent a right lower bilobectomy.

Methods We retrospectively reviewed the data of patients who had been operated on due to non-small cell lung cancer (NSCLC) from January 2005 to December 2015 from a dataset that was formed prospectively. Of the 4,166 patients who underwent resections due to NSCLC, the files of those who had a right sleeve lower lobectomy (group S) and those who had a right lower bilobectomy (group B) were evaluated. The remaining 25 patients in group B and 18 patients in group S were compared in terms of demographic data, morbidity, hospitalization time, mortality, histopathology, recurrence, and total survival.

Results No significant differences in the demographic or clinical characteristics were observed between the two groups, except that group S had more female patients. Postoperative complications developed in 52% of the patients in group B and 11.1% of the patients in group S ($p = 0.006$). Mean hospitalization time was 9.6 $\pm$ 3.6 (range, 6–19) days in group B and 6.72 $\pm$ 1.5 (range, 4–9) days in group S ($p = 0.001$). All patients received complete resections. The mean patient follow-up time was 42.9 months. No significant difference was found between local and distant recurrences ($p = 1, p = 0.432$). Mean survival time was 89.6 months (5-year rate = 73%), which was 90.6 months (5-year rate = 75.3%) in group B and 63.1 months (5-year rate = 69.3%) in group S ($p = 0.82$).

Conclusion This technique allows for reduced filling of the thoracic cavity by a prolonged air leak and a reduced prevalence of complications. Additionally, the hospitalization time is shortened. It does not produce any additional mortality burden, and total survival and oncological outcomes are reliable. This technique can be used in selected patients at experienced centers.

Keywords
- lung cancer
- right sleeve lower lobectomy
- bilobectomy
- thoracotomy

Introduction

The bronchial sleeve resection was developed as an alternative to pneumonectomy for patients with lung cancer generally originating from the bronchus lobe. This method is recommended particularly for patients with restricted cardiopulmonary reserves.[1] Today, sleeve resections are also used in patients who can tolerate a pneumonectomy.[2–6] The survival rate after sleeve resections is similar to or better than that following a pneumonectomy. The right sleeve lower lobectomy is the least used of the bronchial sleeve operations. This technique can be used in patients with non-small cell lung cancer (NSCLC) that originates from the right

received
December 13, 2017
accepted
March 1, 2018
published online
May 23, 2018

DOI https://doi.org/10.1055/s-0038-1642597.
ISSN 0171-6425.

lower lobe, invades the intermediary bronchus, and enters the middle bronchial lobe. Mostly case-based studies are found in the literature.[7] In this study, we compared a right sleeve lower lobectomy to patients who underwent a right lower bilobectomy in terms of morbidity, hospitalization time, mortality, histopathology, recurrence, and survival.

Materials and Methods

Our Institutional Review Board approved this study (version number 2561).

We retrospectively reviewed the data of patients who had been operated on due to NSCLC from January 2005 to December 2015 from a dataset that was formed prospectively. Of the 4,166 patients who had resections due to NSCLC, the files of those who had a right sleeve lower lobectomy and those who had a right lower bilobectomy were evaluated in detail. Preoperative computed tomography (CT) scans and bronchoscopies, as well as the surgical results and postoperative pathology reports, of group B patients were reviewed. Accordingly, exclusion criteria included the presence of fissure invasion, middle lobe vascular structure invasion, macroscopic tumor invasion in the intermediary bronchus, or interlobar lymph node involvement (►**Fig. 1**).

Five surgeons who specialize in thoracic surgery were present in our clinic during the above-mentioned period and completed the operations. All surgeons had at least 10 years of experience in surgical oncology. Two of these surgeons performed the right sleeve lower lobectomies for the patients meeting the criteria, and the remaining three performed the right lower bilobectomy. The operations performed and their distributions through the years are shown in ►**Fig. 2**.

The demographic data, morbidity, hospitalization time, mortality, histopathological characteristics, development of relapses, and 2- and 5-year survival rates were analyzed. Morbidities were considered undesired conditions that developed during hospitalization or within the first 30 days following the operation. Atelectasis, atrial fibrillation, pneumonia, and prolonged air leakage (>7 days) were investigated. Mortality was considered death occurring within the first 30 days postoperatively or during hospitalization. All patients were assessed in the presence of an oncologist during the postoperative period. The VII TNM staging was used for staging. Chemotherapy was administered if needed. The patients were checked with a physical examination and CT scan every 6 months within the first postoperative 5 years and every year thereafter. Fiber optic bronchoscopy and positron emission tomography CT were requested for patients who were suspected of relapse.

Operative Technique

Anesthesia was administered to all patients using double-lumen intubation. The patients underwent a thoracotomy in the left lateral decubitus position. Each patient was staged intraoperatively. Their fissures were opened and lymph nodes assessed. The vascular and bronchial structures were prepared. The intermediary bronchus was cut immediately after the end of the upper lobe and the middle lobe bronchi were cut in patients who underwent a sleeve lobectomy (►**Fig. 3A**). After ensuring negative surgical bronchial margins with a frozen section examination, an anastomosis was performed continuously with 4/0 propylene sutures (►**Fig. 3B**). A parietal pleural flap was passed between the bronchus and the pulmonary artery. The mediastinal lymph nodes were sampled systematically in

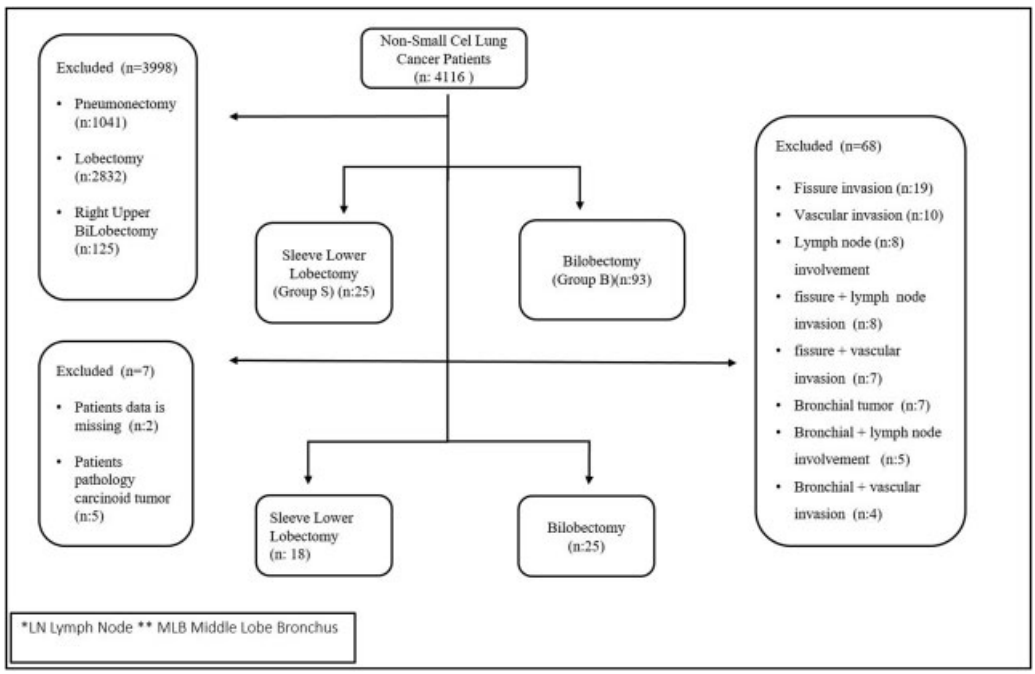

Fig. 1 Patient group selection.

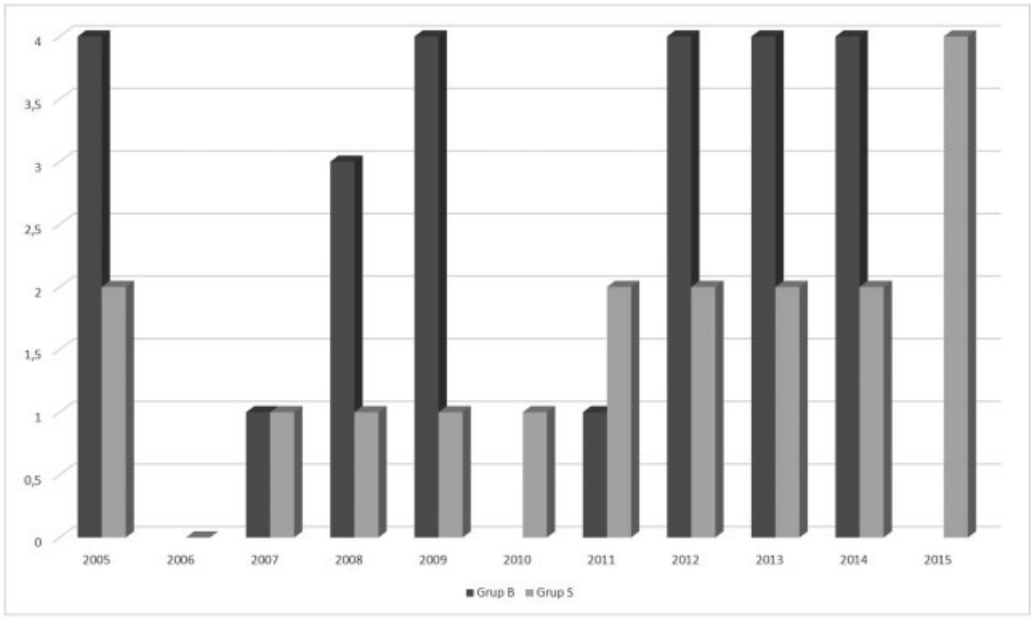

Fig. 2 Distribution of operations through the years.

patients from both groups, and the operation ended after placing the drain. The patients were awakened in the operating room and taken to the surgical intensive care unit. A parenchymal linear stapler was used for separation when the minor fissure was incomplete on the bilobectomies. After resection, the air leaks were repaired with 3/0 polyglactin. Fibrin glue was used for a persistent air leak.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation and discrete variables are presented as frequencies. The demographic and clinical characteristics of the patients and variables, such as age and hospitalization time, were tested for a normal distribution using the Kolmogorov–Smirnov's test. The *t*-test was used to calculate the means of these variables in the two groups, and the chi-square test was used to compare morbidity between the two groups. The calculations were performed using SPSS software (SPSS Inc., Chicago, Illinois, United States). A *p*-value of < 0.05 was considered significant.

Results

The patients were divided into two groups: the bilobectomy group (group B; $n = 93$) and the right sleeve lower lobectomy group (group S; $n = 25$). Of the 93 patients in group B, 68 were excluded because they did not meet the relevant criteria and could not undergo a right sleeve lobectomy. Seven patients in group S were excluded; five underwent surgery for carcinoid tumors and two had missing data.

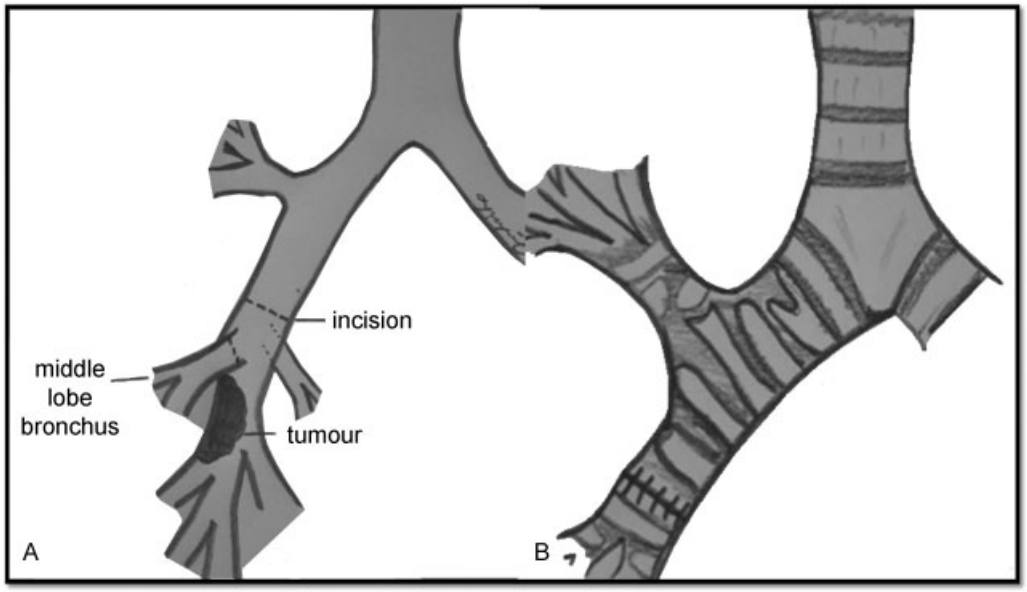

Fig. 3 Illustration of the surgical technique.

Twenty-five patients were included in group B compared with 18 patients in group S. In the end, the cohorts were formed from patients in the two groups who underwent a right sleeve lower lobectomy.

The mean age of group B was 56.8 ± 9.8 (range, 37–77) years and that of group S was 55.8 ± 13.7 (range, 25–79) years ($p = 0.784$). No females were in group B, whereas 11.1% ($n = 2$) of group S consisted of females ($p = 0.169$). No significant differences were found in the demographic characteristics of the patients between the groups (►**Table 1**).

Complications developed in 13 patients in group B (52%) during the postoperative period (prolonged air leak in 11 patients, pneumonia in 1, and atrial fibrillation in 1). Complications developed in two patients in group S (11.1%) (atelectasis in one patient and granulation in the middle lobe entry in one) ($p = 0.006$) (►**Table 2**).

The mean postoperative hospitalization time was 9.6 ± 3.3 (range, 6–19) days in group B and 6.72 ± 1.5 (range, 4–9) days in group S ($p = 0.001$). No operative mortality was observed in either group. Mean operation time was 155 ± 20 minutes in group B and 176 ± 24 minutes in group S ($p = 0.005$) (►**Table 1**).

The groups comprised mostly stage 1B patients ($p = 0.443$) and the histopathological assessments revealed that squamous cell carcinoma was the most common cancer in both groups (group B: 80% and group S: 83.3%) (►**Table 3**).

All patients received a complete resection (R0). Mean patient follow-up time was 42.9 (median, 36) months. During this time, local recurrence developed in 8% ($n = 2$) (postoperative 42 and 66 months) of patients in group B and in 5.6% ($n = 1$) (postoperative 46 months) of patients in group S ($p = 1$). The distant recurrence rates in groups B and S were 24% ($n = 6$) and 11.1% ($n = 2$), respectively ($p = 0.432$) (►**Table 4**).

A Kaplan–Meier's analysis was performed for 25 patients in group B and 18 patients in group S. Mean survival was 90.6 months (95% confidence interval [CI], 73.2–108). Five-year survival was 75.3% in group B (63.1 months) (95% CI, 52.4–73.8) and 69.3% in group S ($p = 0.82$) (►**Fig. 4**).

Table 2 Postoperative complications and hospitalization

Variables	Group B	Group S	*p*-Value
Operation time (min)	155 ± 20	176 ± 24	0.005
Postoperative complication			
Yes, *n* (%)	13 (52%)	2 (11.1%)	0.006
No, *n* (%)	12 (48%)	16 (88.9%)	
Hospitalization (d)	9.6 ± 3.3	6.72 ± 1.5	0.001

Table 3 Histopathological comparisons

Variables	Group B, *n* (%)	Group S, *n* (%)	*p*-Value
Tumor histology			
Squamous cell carcinoma	20 (80%)	15 (83.3%)	1
Adenocarcinoma	5 (20%)	3 (16.7%)	
Pathological stage			
1A	1 (4%)	1 (5.6%)	0.443
1B	10 (40%)	9 (50%)	
2A	4 (16%)	2 (8.7%)	
2B	9 (36.0%)	4 (22.2%)	
3A	1 (4%)	3 (16%)	

Discussion

Sleeve lobectomy is a surgical technique that can generally be used in patients whose disease originates from the lobed

Table 1 Demographic characteristics of patients

Variables	Group B, *n* (%)	Group S, *n* (%)	*p*-Value
Gender			
Male	25 (100)	16 (88.9)	0.169
Female	0	2 (11.1)	
Comorbidity	18 (72)	12 (66.7)	0.707
Cardiac problems (arrhythmia/CF)	8 (32)	5 (27.8)	0.766
COPD	9 (36)	8 (44.4)	0.576
CRF	2 (8)	1 (5.6)	1
Diabetes mellitus	3 (12)	5 (27.8)	0.247
Hypertension	6 (24)	4 (22.2)	1
Previous surgery	2 (8)	5 (27.8)	0.112
Smoking habits			
Smoker	19 (76)	14 (77.8)	1
Nonsmoker	6 (24)	4 (22.2)	

Abbreviations: CF, cardiac failure; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure.

Table 4 Comparison of the lower bilobectomy group and the right sleeve lower lobectomy group in terms of local and distance recurrences

Variables	Group B, *n* (%)	Group S, *n* (%)	*p*-Value
Local recurrence			
Yes	2 (8%)	1 (4.3%)	1
No	23 (92%)	22 (95.7%)	
Distant recurrence			
Yes	6 (24%)	2 (11.1%)	0.432
No	19 (76%)	16 (88.9%)	

bronchi. This technique allows for better protection of the parenchyma and reduces postoperative complications. This option should be used regardless of the patient's age or respiratory/cardiac function. Sleeve resections are preferred in all cases where a complete resection is possible. In their meta-analysis, Shi et al[8] showed that sleeve lobectomies are preferred more than pneumonectomies for early-stage lung cancers.

Fewer complications developed in group S in our study. Fewer incidences of prolonged air leak, in particular, can be explained by the presence of a smaller residual space in the thorax. In their bilobectomy series involving 146 patients, Galetta et al[9] reported a morbidity rate of 47% and a mortality rate of 1.4%, stating that the most frequently experienced morbidity was prolonged air leak in the thoracic space. In their study where they reviewed 1,831 bilobectomy cases, Thomas et al[10] reported that a lower bilobectomy has a threefold higher risk for developing a fistula than an upper bilobectomy. Kim et al[11] reported in their bilobectomy series of 92 patients that mortality rate was 4.3% and morbidity rate was 31%. They stressed that more problems occur in a lower bilobectomy. A retrospective study by Gómez-Caro et al[12] in which lobectomy and bilobectomy were compared showed that 7.9-fold more cardiopulmonary complications developed in patients who underwent lower bilobectomy compared with those who underwent a lower lobectomy. In a study performed by Ludwig et al,[13] complication rates of bilobectomy and sleeve lobectomy were 53 versus 33%. Respiratory function 3 months postoperatively was not significantly different between the groups.

In our study, the complications that developed in group S were associated with anastomosis-related problems. These complications likely developed due to temporary bronchial edema occurring in the anastomotic line and the difficulty in clearing drainage associated with repositioning of the middle bronchial lobe. All of these complications were treated with fiberoptic bronchoscopy. The hospitalization time of group S patients was shorter due to fewer complications. Postoperative air leaks occurred less frequently due to sleeve resection because the minor fissure did not need to be separated in this group. Our previous study showed that sleeve resection has complications.[14]

No operative mortality was seen in our study. As there are no series related to right sleeve lower lobectomy in the literature, no mortality comparison could be made. However, the absence of any mortality suggests that the sleeve resections had no negative effect on mortality.

No significant difference in recurrence was found between the groups. The prerequisite for performing a sleeve resection is the ability to perform a complete resection. R0 resections were performed in both groups. The absence of any difference between the local recurrences of the groups is promising for a right sleeve lower lobectomy to be performed with an appropriate indication. Similarly, no difference was found between the groups with respect to distant recurrences. Local tumor control, which is the main concern in bronchoplasty, is reportedly acceptable.[2,4,6,15] While the recurrence rate ranges between 8 and 23% after a sleeve

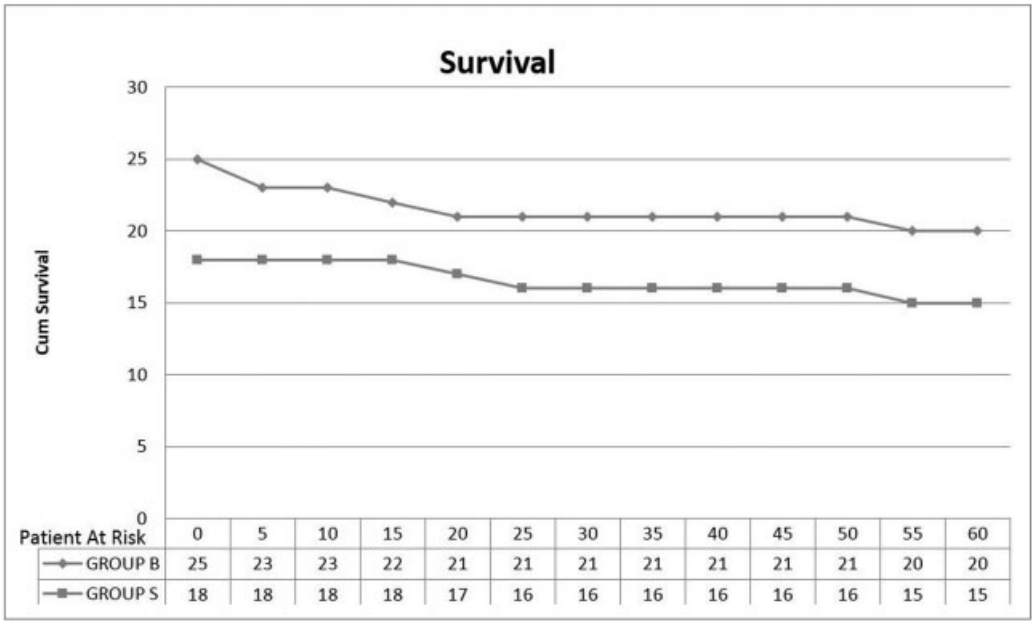

Fig. 4 Survival curves of the bilobectomy and the right sleeve lower lobectomy groups.

lobectomy, it has been reported to be 10 to 14% in pneumonectomies. Park et al[16] found no difference in local recurrences between the two groups.

Parenchymal protective surgery is associated with better prognosis and survival, particularly for early-stage lung cancers. The studies of Okada et al,[4] Deslauriers et al,[5] and Takeda et al[3] reported better survival rates after sleeve lobectomy administered to stage 1 and stage 2 patients. Lobectomy and pneumonectomy have been compared for survival in sleeve studies. No difference was found in our study between 5-year survival of the bilobectomy group and survival of the sleeve lower lobectomy group.

Limitations

The limitations of our study are that it was retrospective; the number of patients was small because a right sleeve lobectomy can only be applied to a relatively limited number of patients; the operations were performed by different surgeons; and general survival was calculated rather than survival by stages, as the number of patients was small. In many series, male sex is a risk factor for complications. However, it was not evaluated in our study because of the absence of females in group B. The mean age of patients in our study was lower than in oncological surgery patients in the literature. The reason for this is that the mean age of patients with NSLC treated with surgery between these years was 56 ± 15.2 years. Therefore, our age-related complication rate was low. The patients' postoperative lung function was not compared between the groups due to missing data.

Conclusion

Our study showed that due to protection of the middle lobe, it was easier for the lung to fill the thoracic cavity, leading to reduced rates of prolonged air leakage and other complications. Consequently, hospitalization time was shortened. The surgical technique did not bring an additional mortality burden and the survival rate and oncological outcomes were reliable. Therefore, we believe that this method should be preferred for appropriate patients at experienced centers.

Conflict of Interest
The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1 Thomas CP. Conservative resection of the bronchial tree. J R Coll Surg Edinb 1956;1(03):169–186
2 Fadel E, Yildizeli B, Chapelier AR, Dicenta I, Mussot S, Dartevelle PG. Sleeve lobectomy for bronchogenic cancers: factors affecting survival. Ann Thorac Surg 2002;74(03):851–858, discussion 858–859
3 Takeda S, Maeda H, Koma M, et al. Comparison of surgical results after pneumonectomy and sleeve lobectomy for non-small cell lung cancer: trends over time and 20-year institutional experience. Eur J Cardiothorac Surg 2006;29(03):276–280
4 Okada M, Yamagishi H, Satake S, et al. Survival related to lymph node involvement in lung cancer after sleeve lobectomy compared with pneumonectomy. J Thorac Cardiovasc Surg 2000;119 (4 Pt 1):814–819
5 Deslauriers J, Grégoire J, Jacques LF, Piraux M, Guojin L, Lacasse Y. Sleeve lobectomy versus pneumonectomy for lung cancer: a comparative analysis of survival and sites or recurrences. Ann Thorac Surg 2004;77(04):1152–1156, discussion 1156
6 Gaissert HA, Mathisen DJ, Moncure AC, Hilgenberg AD, Grillo HC, Wain JC. Survival and function after sleeve lobectomy for lung cancer. J Thorac Cardiovasc Surg 1996;111(05):948–953
7 Boudaya M-S, Abid W, Mlika M. Sleeve right lower lobectomy: a rarely performed extended resection. Indian J Surg 2016;78(01): 74–76
8 Shi W, Zhang W, Sun H, Shao Y. Sleeve lobectomy versus pneumonectomy for non-small cell lung cancer: a meta-analysis. World J Surg Oncol 2012;10(01):265
9 Galetta D, Solli P, Borri A, et al. Bilobectomy for lung cancer: analysis of indications, postoperative results, and long-term outcomes. Ann Thorac Surg 2012;93(01):251–257, discussion 257–258
10 Thomas PA, Falcoz P-E, Bernard A, et al. EPITHOR group. Bilobectomy for lung cancer: contemporary national early morbidity and mortality outcomes. Eur J Cardiothorac Surg 2016;49(02): e38–e43, discussion e43
11 Kim AW, Faber LP, Warren WH, Shah ND, Basu S, Liptay MJ. Bilobectomy for non-small cell lung cancer: a search for clinical factors that may affect perioperative morbidity and long-term survival. J Thorac Cardiovasc Surg 2010;139(03):606–611
12 Gómez-Caro A, Garcia S, Reguart N, et al. Determining the appropriate sleeve lobectomy versus pneumonectomy ratio in central non-small cell lung cancer patients: an audit of an aggressive policy of pneumonectomy avoidance. Eur J Cardiothorac Surg 2011;39(03):352–359
13 Ludwig C, Morand P, Schnell J, Stoelben E. Preserving middle lobe to improve lung function in non-small-cell lung cancer. Asian Cardiovasc Thorac Ann 2009;17(02):153–156
14 Metin M, Sayar A, Demir A, et al. Sleeve resections: techniques of anastomoses, morbidity, mortality. Turkish J Thorac Cardiovasc Surg 2001;9(03):160–162
15 Ma Z, Dong A, Fan J, Cheng H. Does sleeve lobectomy concomitant with or without pulmonary artery reconstruction (double sleeve) have favorable results for non-small cell lung cancer compared with pneumonectomy? A meta-analysis. Eur J Cardiothorac Surg 2007;32(01):20–28
16 Park JS, Yang HC, Kim HK, et al. Sleeve lobectomy as an alternative procedure to pneumonectomy for non-small cell lung cancer. J Thorac Oncol 2010;5(04):517–520